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IMPLEMETATION OF CLEANER PRODUCTION IN FOUNDRY

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ABSTRACT

Cleaner production is a idea which applying on products, manufacturing process and pollution prevention for economic and environmental sustainable development. How to implement cleaner production in Indian foundry industry is the main issue in the field of sustainable development of economy. Waste has to be regenerated and used again as a material to the maximum possible extent. Waste is becoming an increasingly traded product, where excellent profits can be made.devlopment of the foundry with new technology of cleaner production, namely: improving housekeeping, improve raw materials, increasing the metal yield, improve the efficiency energy use, reduce foundry by-products and improved production planning. This paper purpose is to suggest modal for each foundry department(if required) which implement different cleaner production technologies to improve environmental and economic benefits.

KEYWORDS: Environmental Sustainable Development, Indian Foundry Industry

INTRODUCTION

The numerous manufacturing processes of casting like pattern making, moulding and coremaking ,melting and casting, fettling and testing and inspection.all the process are accompanised by evalution of solid waste solid waste,air emissions, wastewater and noise pollution.the whole process of casting may be classified into five stage which is shown in Figure 1.

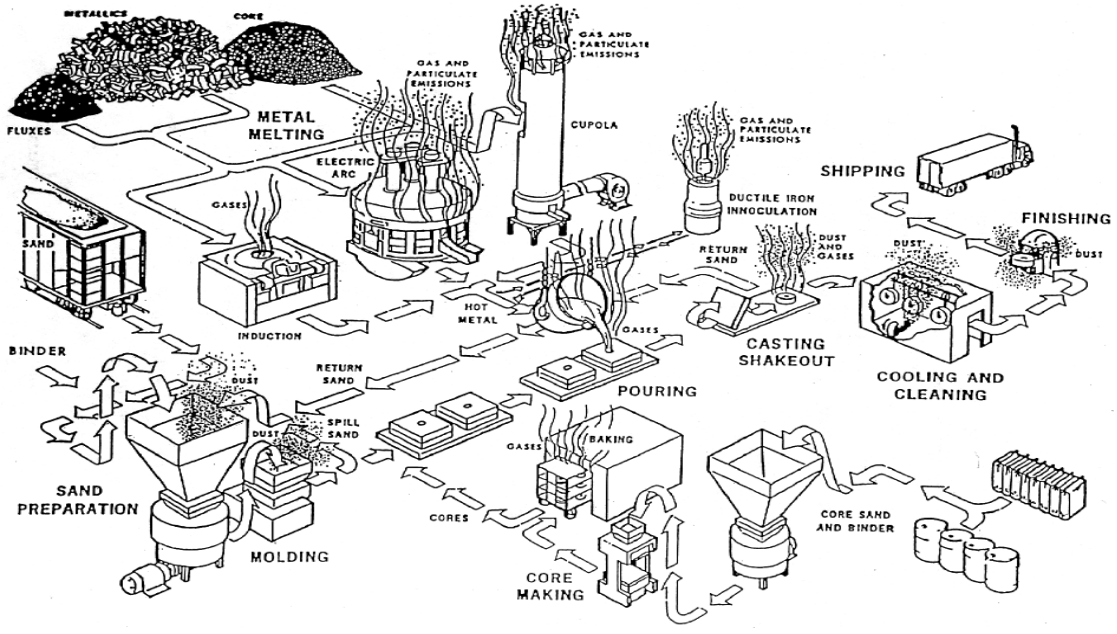

Figure 1: Casting Process

Process of Producing Castings & their Pollutants

Pattern Making

Patterns materials are typically metal , plastic ,wood or plaster.pattern makers have a wide range of tools available to them ,including woodworking and machining tools . mechanical connectors and glues are used to join pattern pieces together. pollutants outputs given below.

- Pollutants Outputs

  Air Emission: VOC (volatile organic compound) :glues, epoxies, and paints.

  Waste Water: Little or no wastewater generated but there watutilization.

  Residual Wastes: Scrap pattern materials

Molding and Core Making

Mould are prepared by mixing of sand and chemical binders with the help of patterns to get the same shapes to pattern.coremaking will be useful for the inner one,or at least the parts not directly attainable by moulding.and pollutants outputs given below.

- Pollutants Outputs

  Air Emissions: Particulates, metal oxide fumes, carbon monoxide, hydrogen sulfide, sulfur dioxide, and nitrous oxide. Also, Benzene, phenols, and other hazardous air pollutants

  Wastewater: Wastewater containing metals, elevated temperature, phenols and other organics from wet dust collection systems and mold cooling water

  Residual Wastes: Waste mold and core sand potentially containing metals and residual chemical binders.

Melting & Casting

Metals (metal scrap,ingot and returned castings) will be melted in suitable furnaces to get the furnaces to get the required composition and molten metal will be poured into the molds and pollutant outputs given below.

- Pollutants Outputs

  Air Emissions: Products of combustion, oil vapors, particulates, metallic oxide fumes

  Wastewater: Scrubber wastewater with high pH, slag cooling water with metals, and non- contact cooling water

  Residual Wastes: Spent refractory material potentially containing metals and alloys

Fettling

After solidification of castings,these will be removed from mold boxes and unwanted metal attachments like runner and risers will be removed and sand adhered to the casting will be cleaned. Later these castings will be sent for futher operations like heat treatment and machining. and pollutant outputs given below.

- Pollutants Outputs

  Air Emissions: VOCs, dust and metallic particulates

  Wastewater: Waste cleaning and cooling water with elevated temperature, solvents, oil and grease, and Suspended solids

Residual Wastes: Spent solvents, steel shot, metallic particulates, cutting wheels, metallic filings, dust from collection systems, and wastewater treatment sludge

Testing and Inspection

Before dispatching of the castings,visual and dimensional inspection carried out.as per customer requirements non destructive tests like ultrasonic radiography tests are carried out to know the internal soundaness of castings.

METHODOLOGY

In India there are more than 5000 foundries in India (The institute of Indian foundrymen2012) There are many hubs of foundries like West Bengal, Gujarat, Maharashtra, Tamilnadu, Karnataka, Andra Pradesh and Jharkhand.

Ahmadabad, located in the state of Gujarat, is an important foundry cluster in Western India. The geographical spread of the cluster includes Ahmedabad, Vidyanagar, Rajkot, Bhavnagar etc.

To have true picture of these hubs, foundry from Ahmadabad were chosen for study of investigation of wastes then implement cleaner production. Data is collected from REAL CAST FOUNDRY PVT LTD, Ahmedabad. These foundry produces castings by sand castings. These foundry is ferrous in nature.

Waste measurement is carried out with the help of BHAGAVATI ENVIRONMENT CARE PVT LTD, Ahmedabad. Data is compared with the standards of CPCB (Central pollution control board) and MOEF (Ministry of environment and forests).

RESULTS & DISCUSSIONS

The following results were obtained from the real cast foundry. The readings are as below.

Table 1: Experimental Results Major Waste and Emission

Air Emission				
No.	**Source**	**Pollutant in µg/m^3**		
		PM	**NO_2**	**SO_2**
1.	Furnace Operation	1977	NA	161
2.	Preparation of cores and moulds	2134	167	290
3.	Casting	1667	NA	179
4.	Shakeout and reclamation	3147	NA	153
5.	MOEF Standard	3000	150	150

Solid Waste					
No.	**Source**	**Concentration in mg/kg**			
		Cu	**Zn**	**pb**	**Ni**
1	Sand waste	190	71	180	130
2	Dust	143	138	255	199
3	Slag waste	482	297	52	490
4	MOEF standard	300	1000	100	50

Noise Pollution		
No.	**Source**	**Pollution(dB(A))**
1	Scrap handle	57
2	Furnace operation	53
3	shakeout	48
4	compressor	80
5	Crane	59
6	CPCB standard	75

Sand and Moulding Process (Paramètres Included)

Table 2: Sand and Moulding Process

Input (tpa)	
Silica Sand	260
Catalyte	1.3
Resin	3.25
LPG gas	2.5
Water base Graphite Paint (Powder)	2
Thinner base Graphite Paint (Powder)	0.2

Melting Process (Parametres Included)

Table 3: Melting Process

Input (tpa)		Output (tpa)	
MS	124	Molten Iron	415
CRC	187	Slag	12
RR	93		
Rejection	15		
Slag 30	4		

Casting Process (Paramètres Included)

Table 4: Casting Process

Input(tpa)	Output(tpa)	
Molten Iron 415	Casting	307
	Runner & Riser	93
	Reject	15
	Solid waste	280
	Dust	12

CONCLUSIONS

From above table following conclusion can be made

Solid Waste

Regarding to solid waste, there are drastic deviations in foundry Solid wastes (sand waste, dust, and slag waste) compare to Ministry Of Environment and Forests standard.

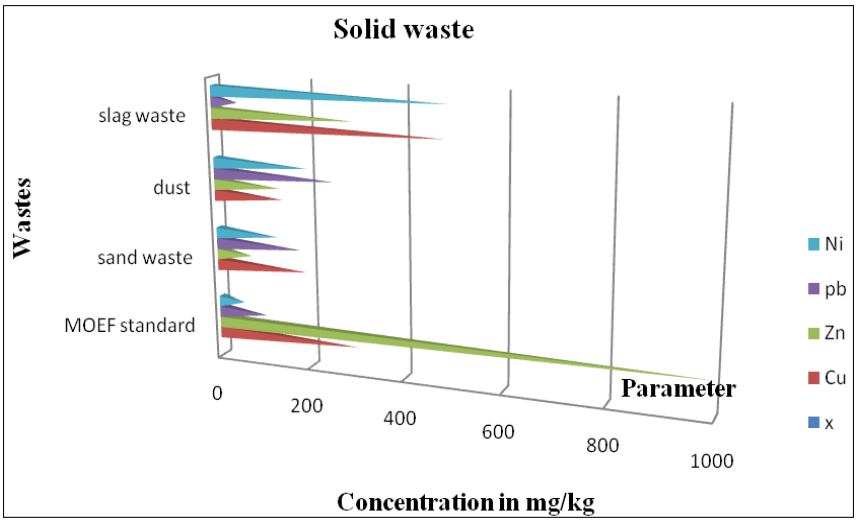

Figure 2: Relationship between Parameter and Concentration of Metals in Solid Waste

Air Emission

Regarding air emission, there are drastic deviations in all department compare to Ministry Of Environment and ForestsStandard.

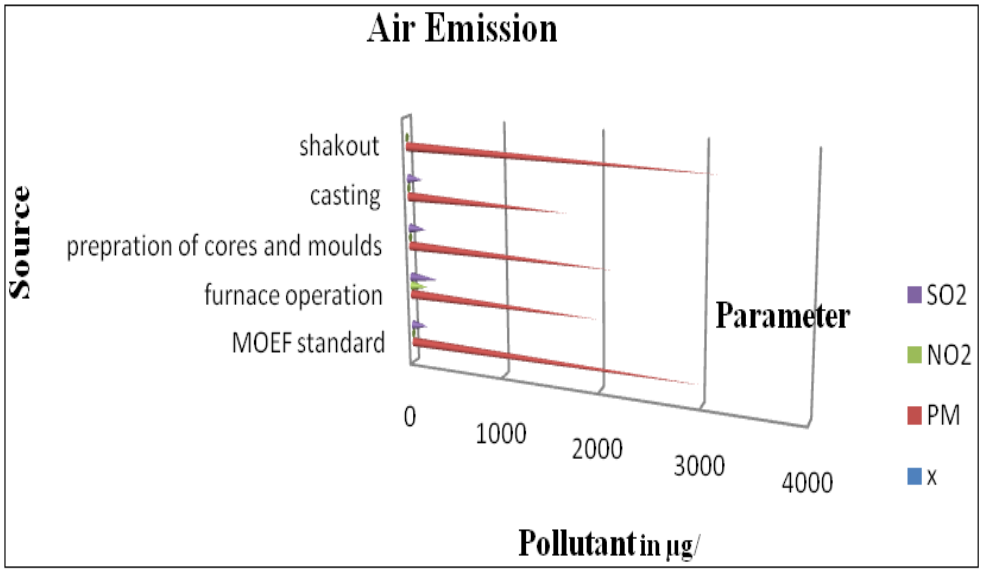

Figure 3: Relationship between Parameter and Pollutant in Air Emission

Noise Pollution

Regarding noise pollution, there are drastic deviations in all department parameter compare to Central Pollution Control Board standard.

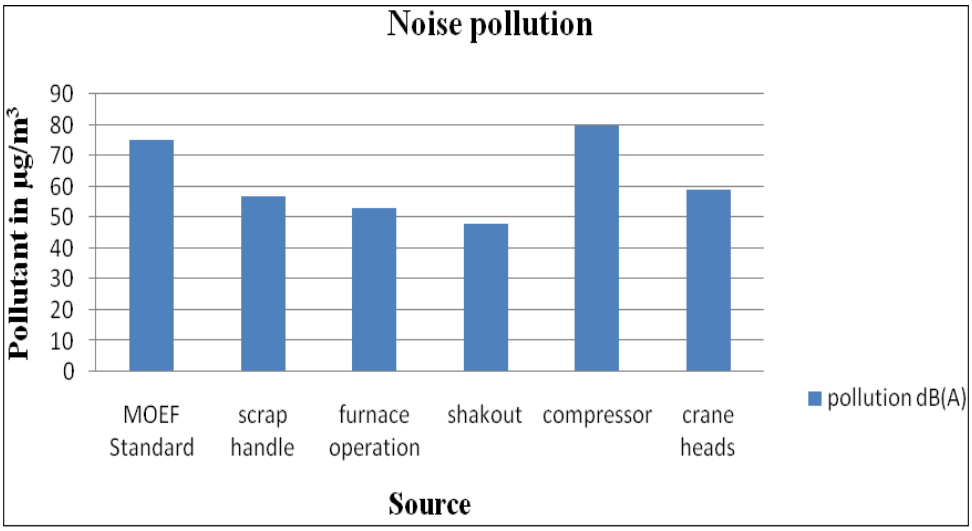

Figure 4: Relation between Source of Noise and Pollutant

RECOMMENDATION

Improve Layout and Design of Foundry

- **Achieved Environmental Benefits**

  Improving layout and design of processes will eliminating the generation of waste materials at source. To improve process layout may minimize non value adding processes like unnecessary movement of materials into and out of process areas, time consuming and wasteful processes such as unnecessary space for inventory of consumables and work in progress.

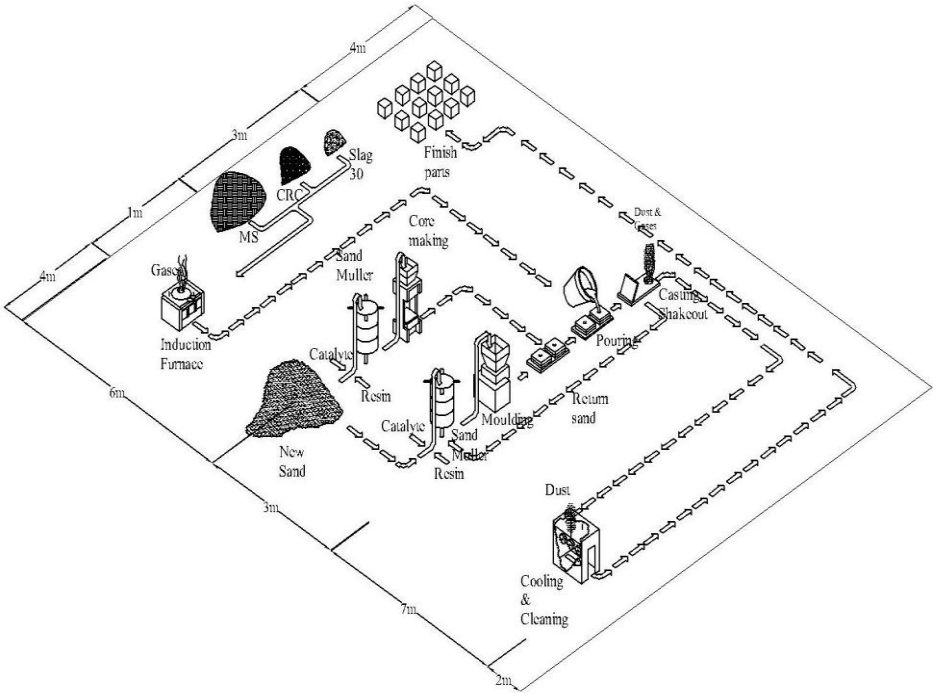

Figure 5: Present Layout and Design in Real Cast Foundry

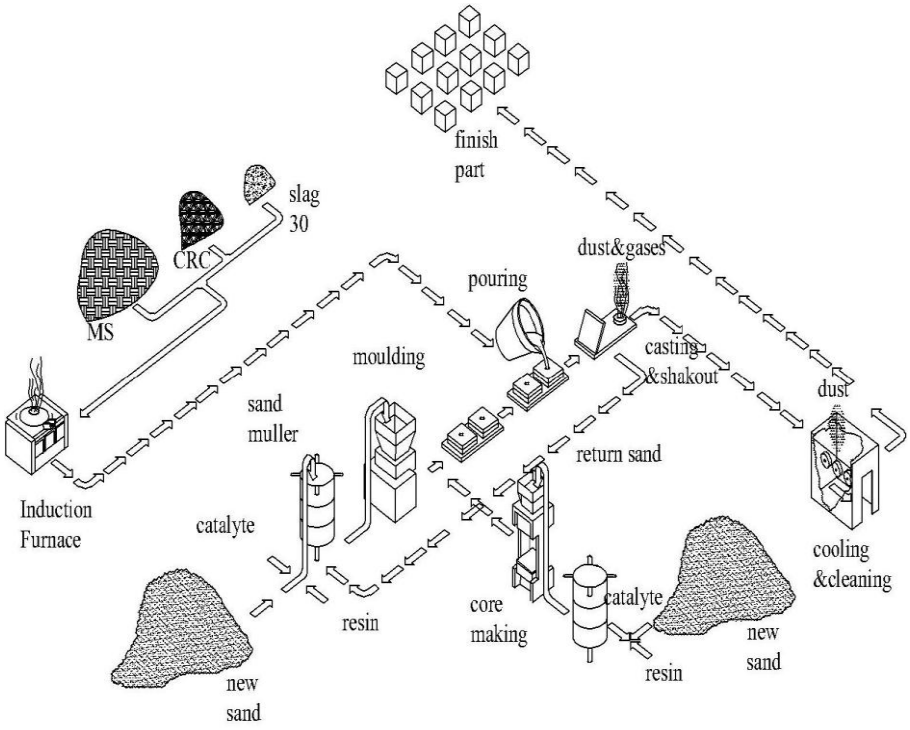

Figure 6: Suggested Model for Improving the Layout and Design of Processes

- **Applicability**

  These techniques apply to exiting foundries.

- **Economics**

  Direct labour costs reduced due to reduce unnecessary movement of materials.

- **Driving Force for Implementation**

  Improve the efficiency of the operation at the foundry.

Air Emission Control (Centralized Dust Collection System)

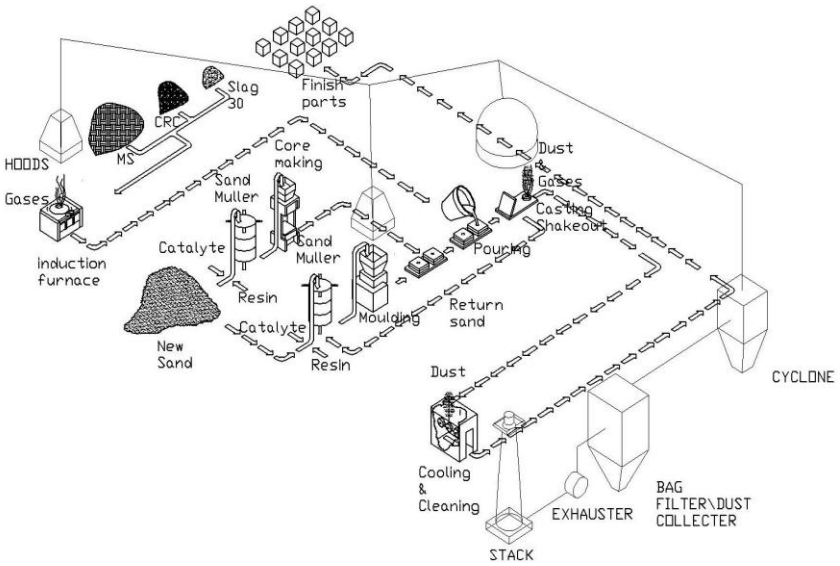

Figure 7: Centralized Dust Collection System at Foundry

- **Achieved Environmental Benefits**

  Reduction of dust emissions.

- **Cross Media Effects**

  The extraction and cleaning of dust and gases consumes energy.

- **Applicability**

  These techniques apply to exiting foundries.

- **Driving Force for Implementation**

  Regulation on dust emissions and occupational health and safety.

Sand and Moulding Process

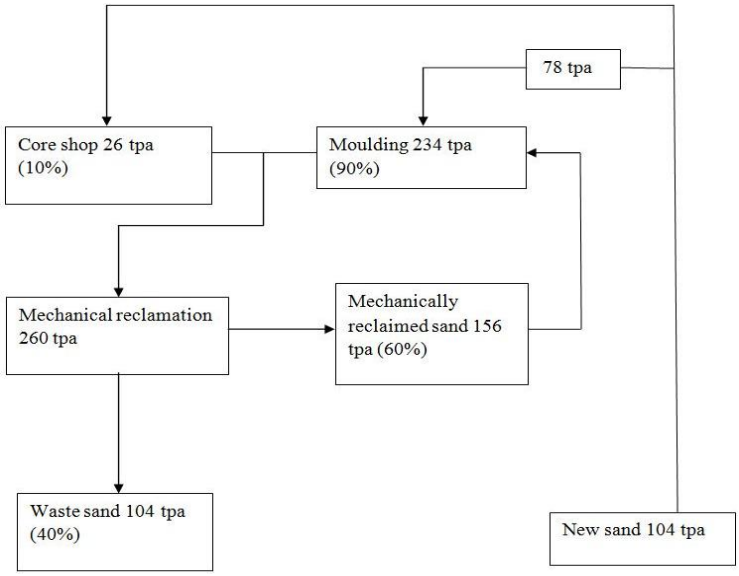

Figure 8: Present Sand and Moulding Process

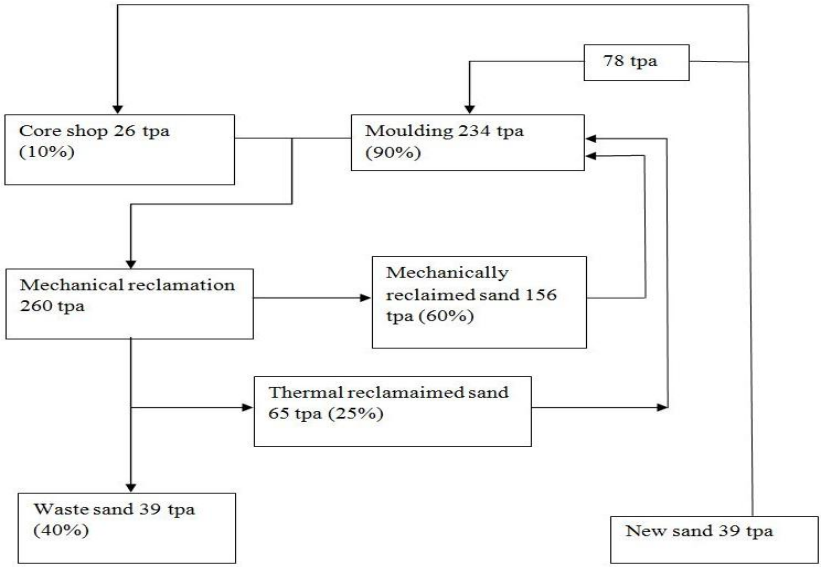

Figure 9: Suggested Thermo-Mechanical Reclamation Model

Note: Thermal reclamation sand quantity 25% is approximately value from literature review

- **Achieved Environmental Benefits**

  Reduction of the amount sand for disposal and reduction in the consumption of new primary sand.

- **Cross Media Effects**

  Thermal regeneration requires fuel and generates emissions of dust and combustion related compounds [NOX, CO; and in the case of oil SO2]

- **Applicability**

  Thermal systems are normally used for chemically bonded sand systems and mixed sand.

- **Driving Force for Implementation**

  Legistion using high disposal fees to reduce the amount of residues for disposal.

Waste Heat Utilization at Furnace

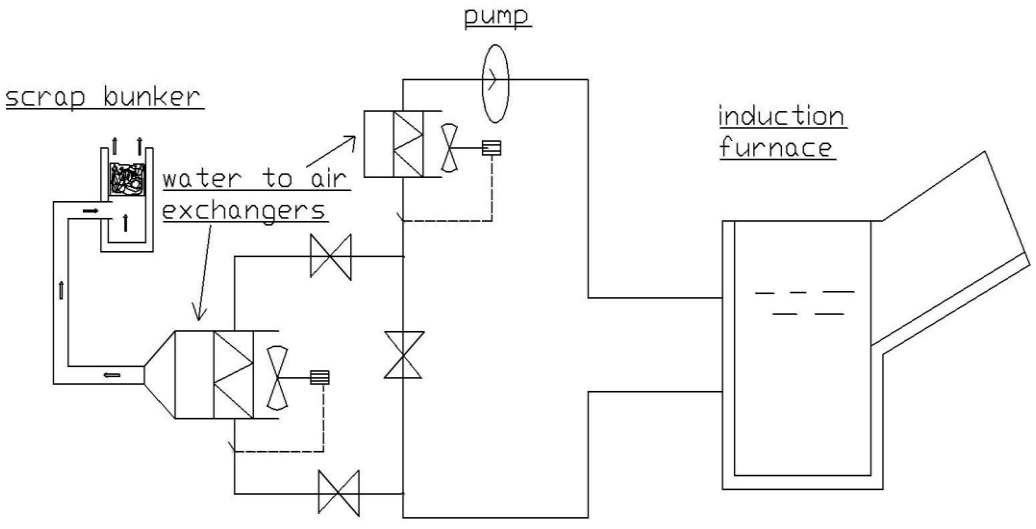

Figure 10: Waste Heat Utilization at Furnace

- **Achieved Environmental Benefits**

  The presence of water in the scrap can potentially be very dangerous. The heat in the furnace cooling system is used in drying of material then improve the energy efficiency.

- **Applicability**

  Waste heat can be utilized must match the times at which the furnace is operating.

- **Economics**

  A foundry attempting to make use of the heat from the cooling circuit needs to fully evaluate the benefits and then compare them with the cost of the additional equipment.

- **Driving Force for Implementation**

  Increasing energy efficiency at the foundry.

Note: Above suggest model may apply all small and medium scale ferrous foundries.

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REFERENCES

1. Reference document on "Best available techniques in the smitheries and foundry industries", European commison, Spain, July 2004.
2. Report on Cleaner Production Ideas for the Foundry Industry, Center for Environmental Training and International Consulting Austria, 2004.
3. the reengineering process approach for energy efficiency and pollution free environment in foundaries,Dr.R.Rudramoorthy,Mr.Vinod.s. puranik
4. Cleanar production manual for the queensland foundary industry,November 1999.
5. D.P.Mukherjee, Barriers towards cleaner production for optimizing energy use and pollution control for foundry sector in Howrah, Clean Techn Environ Policy, 13, 2011, 111–123.
6. Report on Strategies and Mechanisms for Promoting Cleaner Production Investments in Developing Countries, UNEP (United Nations Environment Programme), 2000. Http://www.uneptie.org
7. The gazette of India, part II,-section 3 – sub section, NEW DELHI MARCH 31, 2012.
8. Jochen Petersen, Mary Stewart & Jim G. Petrie, Management of Ferro- alloy wastes, minerals &energy, 14(4), 1999, 27-35.
9. E.M.Emmima, Ľ.Mihok, A.Pribulová, control of environment and risk in integrated management systems in iron and steel foundry, archive foundary,4(13),2004,74-80.

10. S.Fore,C.T.Mbohwa, Cleaner production for environmental conscious manufacturing in the foundry industry, Journal of engineering, design and technology,8(3),2010, 314-333.

11. Seema Unnikrishnan, D.S.Hegde, Environmental training and cleaner production in Indian industry, Resources, conservation and recycling, 50, 2007, 427-441.

12. Borut Kosec ,Sandra Senčič ,Mirko Soković ,Blaž Karpe, Foundry Waste Management, International Journal for Quality research,2(2),2008,129-133.

13. Victoria PETROESC, Roland Iosif MORARU, industrial pollution and control measures in Romanian foundries, International Journal of Engineering, Tome (IX), 2011, 211-216.

14. R.Krishnaraj, Dr.M.Sakthivel, Dr.S.R.Devadasan, K. Kanthavel, E.Balaji, J.Arulmani, A Journey towards Green Revolution- A case study of foundry, International Journal of Scientific & Engineering Research, 2(7)2011.